Cooperative Research with Industry

Outputs

- Interoperability measurements of Project 25 public safety radios.
- Measurements of ad hoc wireless network performance.
- Measurements of time-based transmitter and receiver performance.
- Measurements of X-band emissions from a newly developed radar.

The Federal Technology Transfer Act of 1986, as amended, allows Federal laboratories to enter into cooperative research agreements with private industry, universities, and other interested parties. The law was passed in order to provide laboratories with clear legal authority to enter into these arrangements and thus encourage technology transfer from Federal laboratories to the private sector. Under this Act, a cooperative research and development agreement (CRADA) can be implemented that protects proprietary information, grants patent rights, and provides for user licenses to corporations, while allowing Government expertise and facilities to be applied to interests in the private sector.

ITS participates in technology transfer and commercialization efforts by fostering cooperative telecommunications research with industry where benefits can directly facilitate U.S. competitiveness and market opportunities. ITS has participated for a number of years in CRADAs with private sector organizations to design, develop, test, and evaluate advanced telecommunication concepts. Research has been conducted under agreements with:

- American Automobile Manufacturers Association
- ARINC
- AudioLogic, Inc.
- Coherent Technologies
- Bell South Enterprises
- Bell Atlantic Mobile Systems
- East Carolina University's Brody School of Medicine
- FirstRF Corporation
- General Electric Company
- GTE Laboratories Inc.
- Hewlett-Packard Company (HP)
- Integrator Corporation
- Intel Corporation
- Lehman Chambers
- Lucent Digital Radio
- Lucent Technologies
- Motorola/Freescale Inc.
- Netrix Corporation
- RF Metrics
- Savi Technologies
- Spectrum Mapping LLC
- Telesis Technology Laboratories
- University of Colorado
- University of Pennsylvania
- US WEST Advanced Technologies
- US WEST New Vector Group

Not only does the private sector partner benefit, but the Institute is able to undertake research in commercially important areas that it would not otherwise be able to do. Active CRADAs in FY 2005 are described below.

The State of Wyoming and ITS cooperated in the testing of the interoperability of Project 25 radio equipment for a statewide public safety wireless network. In support of the State of Wyoming procurement of new public safety radio equipment, ITS worked with the various vendors to test the performance and interoperability of their various radios. This work supported Wyoming's determination of which equipment would best meet the state's public safety communication needs. It also provided results useful to ITS' support of various Federal departments and agencies involved with public safety.

The University of Colorado conducted measurements of the performance of ad hoc wireless networks with both ground-based and airborne terminals at ITS' Table Mountain Field Site. The Table Mountain Field Site is a National Radio Quiet Zone protected by Federal Regulation. Using IEEE 802.11 type equipment, routing protocols were tested and the performance of the ad hoc networks monitored. These measurements are contributing to the development of new wireless ad hoc network technologies.

ITS supported RF Metrics in RF link testing between a Time-Based Transmitter and a Time-Based Receiver at the Table Mountain Field Site. These systems are general purpose, software-controlled radios with a special distinction. The transmitter is capable of adjusting the output waveform in time to 1 nanosecond RMS of an input time

ITS and RF Metrics staff at the Table Mountain field site, preparing to measure the characteristics of the electromagnet emissions from a newly developed X-band radar (photograph by F.H. Sanders).

reference. The receiver is capable of time-stamping the received signal with the same resolution. The purpose of this test was to establish the RF link between the two systems in a real-world environment, and make measurements of the system performance during the communication session.

RF Metrics and ITS also made X-band radar emission measurements at the Table Mountain Field Site. These measurements helped RF Metrics characterize the emissions of a newly designed radar for the manufacturer. ITS benefited by learning how well industry could use the International Telecommunication Union – Radiocommunication Sector Recommendation M.1177 to perform radar emission measurements. ITS was the principal contributor to the Recommendation.

Cooperative research with private industry has helped ITS accomplish its mission to support industry's productivity and competitiveness by providing insight into industry needs. This has led to adjustments in the focus and direction of other Institute programs to improve their effectiveness and value.

ITS is interested in assisting private industry in all areas of telecommunications. The pages of this technical progress report reveal many technological capabilities that may be of value to various private sector organizations. Such organizations are encouraged to contact ITS if they believe that ITS may have technology useful to them. Because of the great commercial importance of many new and emerging telecommunication technologies, including third generation wireless (3G), wireless local area networks, digital broadcasting, and intelligent transportation systems, ITS will continue to vigorously pursue technology transfer to the private sector through CRADAs and thereby contribute to the rapid commercialization of these new technologies. ITS also plans to commit substantial labratory resources to the development and standardization of new telecommunication technologies.

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ITU-R Standards Activities

Outputs

- Technical support to the U.S. Administration in Working Party 8B, the Radar Correspondence Group, and Joint Rapporteurs Group 1A-1C-8B, as well as Study Group 3 (see pp 36-37).
- Measurements to determine aggregate emission characteristics and performance of prototype 5-GHz dynamic frequency selection devices.
- Tests and measurements performed on effects of interference from communication system signals into a maritime radionavigation radar.
- Presentations to the ITU-R Radar Seminar.
- Joint development of a method for measuring radar antenna patterns across broad frequency ranges simultaneously with measurement of radar emission spectra.
- Joint measurements of the effects of transmitter rotary joints on radar emission spectra.

Success in worldwide telecommunication markets, as well as effective and compatible use of telecommunications technologies both domestically and abroad, is critical to the long-term economic health of the United States. To achieve these goals, the U.S. Administration actively participates in the single most important worldwide telecommunications standards and regulatory body, the International Telecommunication Union's Radiocommunication Sector (ITU-R), to further its objectives with regard to all forms of wireless communication on a worldwide basis. ITS in turn provides important, ongoing technical support for the U.S. Administration in ITU-R Study Groups 3 and 8; Working Party (WP) 8B; the Radar Correspondence Group (RCG), and the Joint Rapporteurs Group (JRG) 1A-1C-8B. Current areas of interest include (but are not limited to): potential reallocation of radar spectrum; effects on radars of interference from communication systems; dynamic frequency selection technology proposed for 5-GHz spectrum sharing between communication systems and radars; development of radar emission spectrum measurement techniques; and development of more efficient radar spectrum emissions.

A number of proposals have been made by non-U.S. Administrations in ITU-R to introduce communication systems into bands that have heretofore been allocated for radars on a primary basis. One of these is dynamic frequency selection, in which communication systems automatically sense the presence of radar signals and avoid operations on locally occupied radar frequencies. Another approach that has been suggested is to allow interference from communication systems to radars on some sort of statistical basis.

Since the U.S. Administration has made an enormous investment in the development and deployment of both military and civilian radars, it is essential that new systems proposed for spectrum sharing with radars be shown to be electromagnetically compatible with existing and future radars. To this end, in FY 2005 ITS engineers tested the new technology, called dynamic frequency selection (DFS), for the U.S. Administration. The tests were conducted jointly by ITS, the NTIA Office of Spectrum

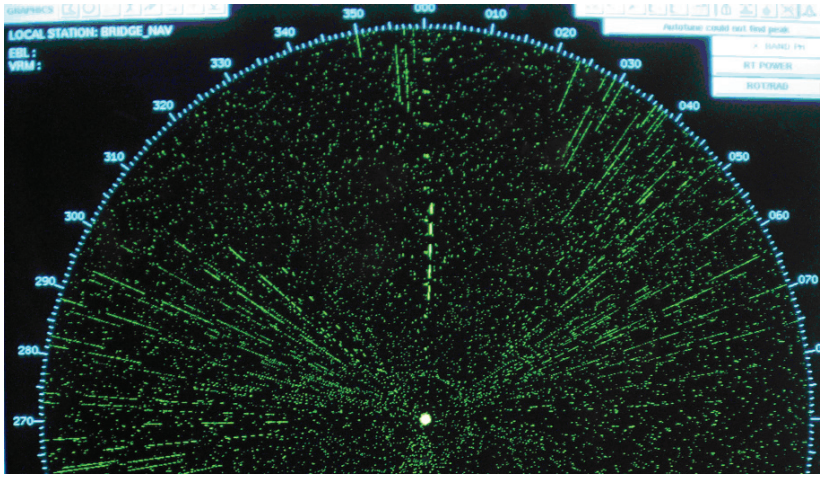

Figure 1. Interference effects in a radar receiver during ITS testing in support of the US Adminstration in ITU-R. Photo by F.H. Sanders.

Management (OSM), other Federal agencies, and industry. Several 5-GHz DFS RLAN prototypes were tested at the ITS Boulder laboratory to determine the extent to which they could successfully sense the presence of radar signals; those results were used by the U.S. Administration at ITU-R meetings in FY 2005.

Figure 2. The 2005 ITU-R Radar Seminar in progress (photograph by F.H. Sanders).

Regarding the statistically-allowed interference technique, ITS and OSM have worked together for several years to study the effects of interference in radar receivers. In FY 2005, interference tests and measurements were performed by ITS and OSM engineers on a maritime radionavigation radar at a Coast Guard site. Interference signals were injected into the radar receiver while targets were observed. At a variety of interference levels, the effects on target detection were observed. The effects of swept-frequency pulses generated by some other radars, called chirped pulses, were also studied. The radar receiver was found to be highly sensitive and susceptible to interference from communication signals at low levels, well below the noise floor of the radar. However, no interference effects were noted in the presence of chirped pulses and other types of radar pulses; these results indicated that the radionavigation radar was highly compatible with other radar systems but not so compatible with communication signals. The test results have been used for U.S. Contributions in WP 8B.

An ITS engineer chairs the Radar Correspondence Group, and ITS provides ongoing support and written Contributions for JRG 1A-1C-8B on future development of radar technology in the X band (9300-9500 MHz). Using data gathered from radar emission measurements at the ITS Table Mountain facility, two ITU-R Contributions were written, calling for changes in the current ITU-R procedures for measurements of radar spectra. In yet another Contribution, a new method for simultaneous measurement of radar emission spectra and antenna patterns across broad frequency ranges was described, again based on data taken at the Table Mountain facility.

ITS and OSM engineers wrote two presentations for the U.S. Administration that were given to the ITU-R as part of its 2005 Radar Seminar. The presentations summarized the results of U.S. studies on DFS, and the results to date of U.S. radar interference studies.

Finally, in FY 2005 ITS organized and hosted an important meeting of Study Group 3 in Cleveland, Ohio, on propagation studies and issues.

Recent Publications

F.H. Sanders, R. Hinkle, and B. Ramsey, "Measurement procedures for the radar spectrum engineering criteria (RSEC)," NTIA Report TR-05-420, Mar. 2005.

F.H. Sanders, "Bandwidth dependence of emission spectra of selected pulsed-CW radars," NTIA Technical Memorandum TM-05-431, Aug. 2005.

F.H. Sanders and B.J. Ramsey, "Comparison of radar spectra on varying azimuths relative to the base of the antenna rotary joint," NTIA Technical Memorandum TM-05-430, Aug. 2005.

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ITU-T & Related U.S. Standards Development

Outputs

- Leadership of ITU-T and related U.S. telecommunications standards committees.
- Technical contributions presenting U.S. standards proposals and ITS research results.
- Proposed ITU-T Recommendations and associated U.S. industry standards.

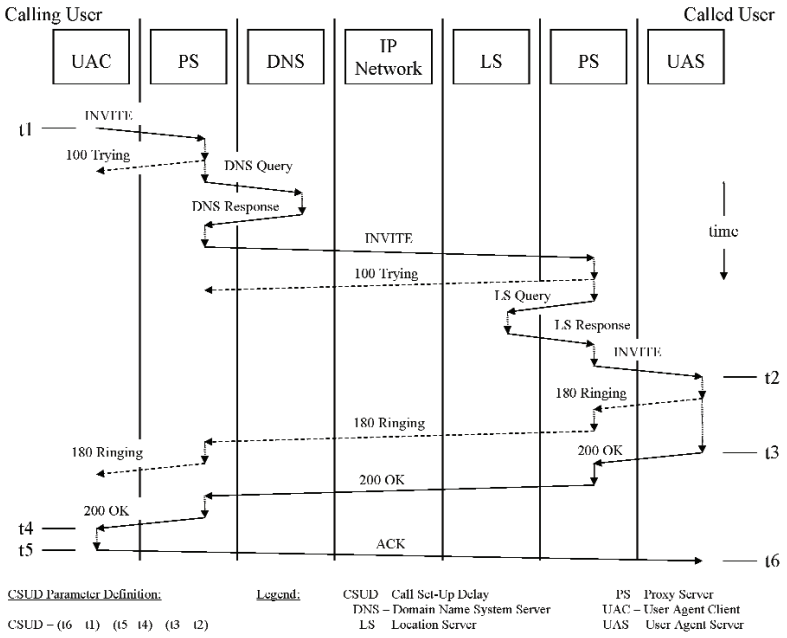
The Institute has a long history of leadership, technical contributions, and advocacy of U.S. Government and industry proposals in the International Telecommunication Union's Telecommunication Standardization Sector (ITU-T) and related U.S. standards organizations. ITU-T is a specialized agency of the UN, responsible for developing the international standards (Recommendations) providers use to plan, interconnect, and operate public telecommunication networks and services worldwide. ITU-T's Recommendations impact both the evolution of U.S. telecommunications infrastructures and the competitiveness of U.S. telecommunications products in international trade.

The Institute's long-term goal in ITU-T (and in related national standards work) is to motivate the standardization of user-oriented, technology-independent measures of telecommunication Quality of Service (QoS) — and to relate those user-oriented measures with the technology-specific performance metrics and mechanisms providers use to provision and operate networks. This ITS work promotes fair competition and technology innovation in the telecommunications industry, facilitates interworking among independently-operated networks and dissimilar technologies, and gives users a quantitative, practical means of defining their telecommunication requirements and selecting products and services that meet them.

In FY 2005, the Institute provided leadership in two key ITU-T groups: Study Group (SG) 13 and SG 9's Working Group on Quality Assessment. SG 13 is developing technical standards that will enable the convergence of circuit-switched and packet-switched networks in Internet Protocol (IP) based Next Generation Networks (NGNs). SG 13 is also responsible for NGN standardization release planning and project management. An ITS staff member serves as Vice Chair of ITU-T SG 13 and its NGN Focus Group (FGNGN), and chairs SG 13's Working Party (WP) 4, which develops technical standards on NGN QoS and Operation, Administration, and Maintenance (OAM). The FGNGN in particular has attracted strong industry support, with international meetings every two months, average attendance exceeding 150, and over 900 technical contributions during FY 2005. SG 9's Working Group on Quality Assessment defines quality objectives for integrated broadband cable networks and television and sound transmission. In that group ITS chairs Question 14/9, "Objective and Subjective Methods for Evaluating Audiovisual Quality in Multimedia Services." ITS also provides leadership and technical contributions in the ITU affiliated Video Quality Experts Group (VQEG) and the Alliance for Telecommunications Industry Solutions (ATIS) Network Performance, Reliability and Quality of Service Committee (PRQC), formerly T1A1. VQEG works in conjunction with ITU-T SG 9 and ITU-R WP 6Q (Broadcasting Services — Performance Assessment and Quality Control) to develop objective, computer implementable, perception-based video quality metrics (VQMs) that emulate the human visual system. PRQC develops national standards and contributes strongly to ITU-T standardization in all of these technology areas. ITS also leads the Joint Rapporteur Group on Multimedia Quality Assessment (JRG-MMQA) a cross-cutting ITU-T standards body that unites the video quality expertise of SG 9 with the audio quality expertise of SG 12 in a cooperative effort to develop objective, perception-based metrics for combined audio and video signals in mobile and PC environments.

Under ITS leadership, SG 13/WP 4 drafted three new ITU-T Recommendations during FY 2005: Y.17fw (MPLS management framework), Y.17ethoam (OAM functions and mechanisms for Ethernet-based networks), and Y.123qos (A QoS control architecture for Ethernet-based IP access networks). WP 4 also completed (and SG 13 approved) a revision to ITU-T Recommendation Y.1711 (Operation and maintenance mechanism for MPLS networks). With other leaders, ITS presented NGN standardization results in two ITU-T workshops (NGN Technical Workshop, ITU-T Workshop on NGN in collaboration with IETF). These

two events attracted over 600 attendees. ITS also contributed strongly to the development and approval of a key FGNGN output, published as ITU-T Q-Series Supplement 51 (Signalling Requirements for IP QoS). This specification will be important in standardizing new signalling technologies capable of fully integrating today's wired telephony, video, wireless, and Internet-based infrastructures and services — and motivating the capital investment needed to deploy them.



Example call processing parameter definition.

In PRQC, ITS leadership contributed to new specifications that define priority levels, security requirements, and performance measurement techniques for IP-based networks. ITS also developed PRQC contributions to ITU-T standards work on NGN QoS metrics, specification and apportionment of NGN QoS values, and the allocation of FGNGN work to ITU-T Study Groups. The Institute spearheaded PRQC's FY 2005 efforts to achieve QoS interoperability among NGNs employing different broadband access technologies (e.g., DSL, IPCablecom, Ethernet, Wi-Fi).

In one FY 2005 contribution to PRQC, ITS defined a comprehensive approach to call processing performance specification in networks that use the Internet Engineering Task Force (IETF) defined Session Initiation Protocol (SIP) in establishing and terminating IP media sessions (or "calls"). Such specifications will be needed to support Service Level Agreements (SLAs) and other requirements in deployed NGNs. The figure above shows how one particular SIP-based call processing parameter ("call set-up delay") can be defined. ITS also proposed (and PRQC standardized) an innovative signal processing technology that promotes accurate speech quality measurement in communication systems with rapidly varying transmission delays. Such delays are common in Voice over IP (VoIP) and IP based multimedia communication services, and it will be important to track them in measuring IP network QoS.

ITS has co-chaired the ITU Video Quality Experts Group since its formation in 1997. VQEG enables video experts from many countries to collaborate in developing and evaluating video quality metrics, and its results strongly impact the standardization of VQMs in both ITU-T and ITU-R. The group works primarily via an e-mail reflector, publicly accessible at http://www.VQEG.org. During FY 2005 the number of participants subscribed to this reflector grew to 450. ITS chaired two physical VQEG meetings in FY 2005.

ITS also contributed to VQEG's upcoming Reduced Reference-No Reference (RR-NR) TV and Multimedia video tests during FY 2005, by helping to finalize the test plans and providing video source material. ITS is spearheading new ITU-T work on multimedia quality assessment through its leadership in VQEG and the JRG-MMQA. The latter group met three times during FY 2005.

Recent Publication

C. Dvorak and N. Seitz, "Signalling and interworking challenges for quality of service in the next-generation network," *Journal of the Communications Network*, April-June 2004.

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